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Title: COOLING SYSTEM WITH ADSORPTION REFRIGERATOR

## VERIFIED TRANSLATION OF PRIORITY DOCUMENT

The undersigned, of the below address, hereby certifies that he/she well knows both the English and Japanese languages, and that the attached is an accurate translation into the English language of the Certified Copy, filed for this application under 35 U.S.C. Section 119 and/or 365, of:

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# JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this office.

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[NAME OF THE DOCUMENT] SPECIFICATION

[THE TITLE OF THE INVENTION] COOLING SYSTEM

[CLAIMS]

What is claimed is:

1. A cooling system of heat-generating members for cooling a second heat-generating member (3) disposed in a closed space (1) by cold produced in a refrigerator (4) which is operated by heat absorbed from a first heat-generating member (2) disposed in the closed space (1), the cooling system comprising

a cold storage unit (11) for storing the cold which is produced in the refrigerator (4).

2. The cooling system of heat-generating members according to claim 1, wherein:

the refrigerator (4) includes:

an adsorbent for adsorbing evaporated gas refrigerant and for desorbing the adsorbed refrigerant when being heated; and

an adsorption unit (5) for sealing the adsorbent and the refrigerant,

wherein the refrigerator (4) is a adsorption refrigerator for producing the cold by alternately repeating an adsorbing process where the gas refrigerant is adsorbed to obtain cooling capacity, and a desorbing process where the adsorbed refrigerant is desorbed to regenerate the refrigerant; and

the second heat-generating member (3) is cooled by the cold stored in the cold storage unit (11) in both the adsorbing process

and the desorbing process.

3. The cooling system of heat-generating members according to claim 2, wherein:

in the adsorbing process, liquid refrigerant in the adsorption unit (5) is supplied to the cold storage unit (11); and

the cold storage unit (11) stores the cold by the liquid refrigerant supplied from the adsorption unit (5).

4. The cooling system of heat-generating members according to claim 3, wherein:

a condenser (7) is disposed in the adsorption unit (5) for cooling and condensing the refrigerant removed from the adsorbent in the desorbing process; and

the liquid refrigerant within the adsorption unit (5) is supplied to the cold storage unit (11) for a predetermined time after a start of the desorbing process, so that a liquid surface in the adsorption unit (5) is decreased.

5. The cooling system of heat-generating members according to claim 3, wherein:

a condenser (7) is disposed in the adsorption unit (5) for cooling and condensing the refrigerant removed from the adsorbent in the desorbing process; and

the condenser (7) is disposed at a position higher than the liquid surface in the adsorption unit (5).

6. The cooling system of heat-generating members according to any one of claims 1-5, further comprising

first and second tanks (12a, 12b) for storing a fluid through

which heat absorbed from the first heat-generating member (2) is supplied to the refrigerator (4), wherein:

the fluid before being heated in the first heat-generating member (2) is stored in the first tank (12a), and the fluid after being heated in the first heat-generating member (2) is stored in the second tank (12b); and

a fluid circulation mode is provided so that a flow amount of the fluid supplied from the second tank (12b) to the side of the refrigerator (4) is made larger than that of the fluid supplied from the first tank (12a) to the side of the first heat-generating member (2).

7. The cooling system of heat-generating members according to any one of claims 1-5, further comprising

first and second tanks (12a, 12b) for storing a fluid through which heat absorbed from the first heat-generating member (2) is supplied to the refrigerator (4), wherein:

the fluid before being heated in the first heat-generating member (2) is stored in the first tank (12a), and the fluid after being heated in the first heat-generating member (2) is stored in the second tank (12b); and

at least in the desorbing process, a flow amount of the fluid supplied from the second tank (12b) to the side of the refrigerator (4) is made larger than that of the fluid supplied from the first tank (12a) to the side of the first heat-generating member (2).

8. The cooling system of heat-generating members according to claim 6 or claim 7, further comprising:

a first pump (10a) that controls the flow amount of the fluid

flowing from the first tank (12a); and

a second pump (10d) that controls the flow amount of the fluid flowing from the second tank (12b).

9. The cooling system of heat-generating members according to any one of claims 6-8, further comprising

a heat-exchange facilitating member (12c) for facilitating heat exchange between the fluid in the second tank (12b) and air.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[FIELD OF THE INVENTION]

The present invention relates to a cooling system in which plural heat-generating members are disposed and cooled. The cooling system is effectively used for cooling an electronic unit provided in a base station of a portable phone, an electric equipment, an electric converter, a battery or the like.

[0002]

[PRIOR ART AND PROBLEM TO BE SOLVED BY THE INVENTION]

As a cooling system for cooling an electronic unit provided in a base station of a portable phone, an electric equipment, an electric converter, a battery or the like, the Applicant has already filed an invention (Patent Application No. 2001-182029) in which a second heat-generating member is cooled by an adsorption refrigerator operated by heat that is absorbed from a first heat-generating member.

[0003]

As well known, in the adsorption refrigerator, a cooling capacity can be obtained in an adsorbing process where refrigerant

is evaporated, but the cooling capacity cannot be obtained in a desorbing process where the adsorbed refrigerant is removed and regenerated. Therefore, generally, adsorption units equal to or more than two are provided. One adsorption unit is used in the adsorbing process so that the cooling capacity is obtained, and another adsorption unit is used in the desorbing process so that the refrigerant is desorbed and regenerated by heating an adsorbent. The adsorbing process and the desorbing process are alternately repeated every a predetermined time, thereby the cooling capacity is continuously obtained.

[0004]

However, heat is supplied to the adsorption unit for heating the adsorbent in the desorbing process, while cold (cooling capacity) is mainly produced in the adsorption unit in the adsorbing process. Therefore, immediately after a switching between the adsorbing process and the desorbing process, temperature of cooling water supplied from the adsorption refrigerator is largely changed, and a bad influence may be given to a cooling object such as an electronic equipment.

[0005]

Further, as described above, the adsorption units equal to or more than two are used in order to continuously obtain the cooling capacity. Therefore, it is difficult to reduce manufacturing cost of the cooling system.

[0006]

In view of the above-described problems, it is an object of the present invention to provide a new cooling system different

from a conventional system. It is another object of the present invention to reduce the number of components constructing the cooling system while the cold can be stably supplied to the heat-generating member that is an object body to be cooled.

[0007]

[MEANS FOR SOIVING THE PROBLEMS]

According to the present invention described in claim 1, a cooling system is provided for cooling a second heat-generating member (3) disposed in a closed space (1) by cold produced in a refrigerator (4) which is operated by heat absorbed from a first heat-generating member (2) disposed in the closed space (1).

[0008]

Therefore, the second heat-generating member (3) can be cooled by using the cold stored in the cold storage unit (11). Accordingly, it is possible to continuously cool the second heat-generating member (3) by using a single adsorption unit (5), thereby reducing product cost of the cooling system.

[0009]

However, the present invention is for reducing the number of the adsorption units (5). Therefore, the single adsorption unit (5) can be used, and plural adsorption unit (5) having a reduced number can be also used. That is, the present invention is not limited to only the single adsorption unit (5).

[0010]

Because the second heat-generating member (3) is cooled through the cold storage unit (11), the cold storage unit (11) can absorb a variation in a cooling temperature. Therefore, the

variation of the cooling temperature of a cooling object such as an electronic equipment can be decreased. Accordingly, a bad influence to the cooling object such as the electronic equipment can be decreased.

[0011]

As described above, in the present invention, a new cooling system different from a conventional system can be provided, in which the number of components constructing the cooling system can be reduced while the cold can be stably supplied to the heat-generating members as the cooling objects.

[0012]

According to the present invention described in claim 2, the refrigerator (4) includes an adsorbent for adsorbing evaporated gas refrigerant and for desorbing the adsorbed refrigerant when being heated, and an adsorption unit (5) for sealing the adsorbent and the refrigerant. The refrigerator (4) is an adsorption refrigerator for producing the cold by alternately repeating an adsorbing process where the gas refrigerant is adsorbed to obtain cooling capacity, and a desorbing process where the adsorbed refrigerant is desorbed to regenerate the refrigerant. Moreover, the second heat-generating member (3) is cooled by the cold stored in the cold storage unit (11) in both the adsorbing process and the desorbing process.

[0013]

Accordingly, the variation of the cooling temperature of the second heat-generating member (3) can be further decreased.

[0014]

According to the present invention described in claim 3, in the adsorbing process, liquid refrigerant in the adsorption unit (5) is supplied to the cold storage unit (11), and the cold storage unit (11) stores the cold by the liquid refrigerant supplied from the adsorption unit (5).

[0015]

According to the present invention described in claim 4, a condenser (7) is disposed in the adsorption unit (5) for cooling and condensing refrigerant removed from the adsorbent in the desorbing process. Moreover, the liquid refrigerant within the adsorption unit (5) is supplied to the cold storage unit (11) for a predetermined time after a start of the desorbing process, so that a liquid surface in the adsorption unit (5) is decreased.

[0016]

Accordingly, the whole condenser (7) can be exposed to the refrigerant separated from the adsorbent. Therefore, in the desorbing process, the gas refrigerant can be effectively cooled and condensed in the condenser (7).

[0017]

According to the present invention described in claim 5, a condenser (7) is disposed in the adsorption unit (5) for cooling and condensing refrigerant removed from the adsorbent in the desorbing process. Moreover, the condenser (7) is disposed at a position higher than the liquid surface in the adsorption unit (5).

[0018]

Accordingly, the whole condenser (7) can be exposed to the

refrigerant separated from the adsorbent. Therefore, in the desorbing process, the gas refrigerant can be effectively cooled and condensed in the condenser (7).

[0019]

According to the present invention described in claim 6, the cooling system includes first and second tanks (12a, 12b) for storing a fluid through which heat absorbed from the first heat-generating member (2) is supplied to the refrigerator (4). The fluid before being heated in the first heat-generating member (2) is stored in the first tank (12a), and the fluid after being heated in the first heat-generating member (2) is stored in the second tank (12b). Moreover, a fluid circulation mode is provided so that a flow amount of the fluid supplied from the second tank (12b) to the side of the refrigerator (4) is made larger than that of the fluid supplied from the first tank (12a) to the side of the first heat-generating member (2).

[0020]

Accordingly, the first heat-generating member (2) can be continuously cooled even in the adsorbing process, and of course in the desorbing process.

[0021]

According to the present invention described in claim 7, the cooling system includes first and second tanks (12a, 12b) for storing a fluid through which heat absorbed from the first heat-generating member (2) is supplied to the refrigerator (4). The fluid before being heated in the first heat-generating member (2) is stored in the first tank (12a), and the fluid after being

heated in the first heat-generating member (2) is stored in the second tank (12b). Moreover, at least in the desorbing process, a flow amount of the fluid supplied from the second tank (12b) to the side of the refrigerator (4) is made larger than that of the fluid supplied from the first tank (12a) to the side of the first heat-generating member (2).

[0022]

Accordingly, the first heat-generating member (2) can be continuously cooled even in the adsorbing process, and of course in the desorbing process.

[0023]

According to the present invention described in claim 8, the cooling system includes a first pump (10a) that controls the flow amount of the fluid flowing from the first tank (12a), and a second pump (10d) that controls the flow amount of the fluid flowing from the second tank (12b).

[0024]

According to the present invention described in claim 9, the cooling system includes a heat-exchange facilitating member (12c) for facilitating heat exchange between the fluid in the second tank (12b) and air.

[0025]

Accordingly, the first heat-generating member (2) can be cooled even when an abnormality occurs in the refrigerator (4).

[0026]

Symbol in parentheses of the each above mentioned means is an example showing a correspondence with concrete means described

in following embodiments.

[0027]

[EMBODIMENTS]

(FIRST EMBODIMENT)

In a first embodiment, a cooling system of the present invention is typically used for cooling electronic equipments in a base station 1 for portable phone (called base station).

[0028]

Within the base station 1, a first heat-generating member 2, a second heat-generating member 3 and a cooling device 4 (part surrounded by chain line) for cooling the first and second heat-generating members 2, 3 are provided. For example, the first heat-generating member 2 includes a radio wave output amplifier, a radio wave output control board, a commutator, an electronic equipment, an electric equipment and an electric converter. The first heat-generating member 2 has a relatively large heat-generating amount and a relatively high temperature. The second heat-generating member 3 needs to be cooled in a temperature lower than the first heat-generating member 2. For example, the second heat-generating member 3 includes a circuit control board, a battery, an electronic equipment, an electric equipment and an electric converter.

[0029]

Generally, both the first and second heat-generating members 2, 3 (electric equipment) are not operated separately (independently), but are operatively linked with each other.

[0030]

The cooling device 4 is an adsorption refrigerator that absorbs heat from the first heat-generating member 2, and heats an adsorbent by the absorbed heat. In following, the cooling device 4 is described.

[0031]

The adsorbent adsorbs a refrigerant (e.g., water in the first embodiment), and desorbs the adsorbed refrigerant when being heated. For example, in the first embodiment, a solid adsorbent such as a silica gel and a zeolite is used as the adsorbent.

[0032]

An adsorption unit 5 is a container for sealing therein the refrigerant in an approximate vacuum state. The adsorption unit 5 contains an adsorption core 6 for performing heat exchange between the adsorbent and the thermal medium (water mixed with an antifreezing fluid of an ethylene glycol type in the first embodiment), and an evaporation / condensation core 7 for performing heat exchange between the thermal medium and the refrigerant sealed in the adsorption unit 5. The adsorption core 6 and the evaporation / condensation core 7 are a first heat exchanger and a second heat exchanger respectively.

[0033]

The adsorbent is closely adhered to a surface of the adsorbent core 6, and the adsorbent core 6 is held above the evaporation / condensation core 7 in the adsorption unit 5.

[0034]

An exterior heat exchanger 8 is a radiator, which is disposed outside the base station 1 to perform heat exchange between the

thermal medium and outside air to which heat is radiated. The exterior heat exchanger 8 includes a first heat radiation portion 8a, a second heat radiation portion 8b, and a fan 8c for blowing cooling air. The first heat radiation portion 8a is disposed upstream from the second heat radiation portion 8b in a flow direction of cooling air.

[0035]

A first heat collection portion 2a is a heat exchanger to collect heat generated in the first heat-generating member 2, and to perform heat exchange between the collected heat and the thermal medium. A second heat collection portion 3a is a heat exchanger to collect heat generated in the second heat-generating member 3, and to perform heat exchange between the collected heat and the thermal medium. Rotary valves 9a - 9k for switching a flow of the thermal medium are provided. Further, pumps 10a - 10e are disposed to circulate the thermal medium.

[0036]

A cold storage unit 11 is disposed to store cold generated in the cooling device 4. In the cold storage unit 11 a fluid having a relative large specific heat, such as polyethylene glycol, caprylic acid, tetradecane and water, is used as a cold storage material.

[0037]

The cold storage unit 11 includes a first in-cold-storage-unit heat exchanger 11a in which the thermal medium circulated in the evaporation / condensation core 7 is heat-exchanged with the cold storage material, and a second

in-cold-storage-unit heat exchanger 11b in which the thermal medium circulated in the second heat collection portion 3a is heat-exchanged with the cold storage material. The first in-cold-storage-unit heat exchanger 11a is disposed above the second in-cold-storage-unit heat exchanger 11b in the cold storage unit 11.

[0038]

A first reserve tank 12a is a container for storing the thermal medium before being heated in the first heat-generating member 2, and a second reserve tank 12b is a container for storing the thermal medium after being heated in the first heat-generating member 2. Further, a blower 12c is disposed to blow cooling air toward the outer surface of the second reserve tank 12b. Because the cooling air is blown toward the outer surface of the second reserve tank 12b, heat exchange between the thermal medium in the second reserve tank 12b and air can be improved.

[0039]

Next, operation of the cooling system according to the first embodiment will be now described.

[0040]

1. BASE OPERATION MODE OF COOLING DEVICE 4 (ADSORPTION REFRIGERATOR)

The base operation mode includes first and second base operation modes. The first and second base operation modes are switched by a predetermined time. Here, the predetermined time is suitablely determined based on a time necessary for removing the refrigerant adsorbed in the adsorbent from the adsorbent.

[0041]

In the first embodiment, the first heat-generating member 2 is cooled (heat is absorbed) to become equal to or lower than 150 °C, and the second heat-generating member 3 is cooled to become equal to or lower than an exterior air temperature (e.g., 55-60 °C). Further, the cooling device 4 is configured to have a predetermined cooling capacity corresponding to a temperature range between 70 °C - 100 °C.

[0042]

As shown in following description, in order to stably operate the cooling device 4, the heat-generating amount of the second heat-generating member 3 needs to be always equal to or lower than that of the first heat-generating member 3.

[0043]

1.1 FIRST BASE OPERATION MODE (ADSORBING PROCESS)

As shown in FIG. 2, in this mode, the thermal medium circulates between the second heat collection portion 3a and the second in-cold-storage-unit heat exchanger 11b of the cold storage unit 11, so that the second heat-generating member 3 is cooled by the cold stored in the cold storage unit 11. At the same time, the thermal medium circulates between the first in-cold-storage-unit heat exchanger 11a of the cold storage unit 11 and the evaporation / condensation core 7.

[0044]

Accordingly, liquid refrigerant in the evaporation / condensation core 7 of the adsorption unit 5 absorbs heat from the thermal medium flowing out from the first in-cold-storage-unit

heat exchanger 11a, and is evaporated. Because the evaporated gas refrigerant is adsorbed on the adsorbent, the pressure increase in the adsorption unit 5 is restricted, and the evaporation of the liquid refrigerant is continued to produce cold, until the refrigerant adsorption of the adsorbent is finished. The produced cold is stored in the cold storage unit 11, and is used for cooling the second heat-generating member 3.

[0045]

When the adsorbent adsorbs the gas refrigerant, a heat quantity corresponding to the condensation heat is generated. Further, as the temperature of the adsorbent increases, the adsorption capacity is decreased. Accordingly, the thermal medium cooled in the exterior heat exchanger 8 is supplied to the adsorption core 6, so that the adsorbent is cooled.

[0046]

Moreover, the pump 10a is operated while the pump 10d stops. Therefore, in this case, exhaust heat from the first heat-generating member 2 is recovered, and the recovered heat from the first heat-generating member 2 is stored in the second reserve tank 12b. That is, the thermal medium heated in the first heat-generating member 2 is stored in the second reserve tank 12b.

[0047]

Accordingly, in the first base operation mode (adsorbing process), while the thermal medium stored in the first reserve tank 12a in the next second base operation mode (desorbing process) is supplied to the first heat-generating member 2 to cool the first heat-generating member 2, the exhaust heat (warm heat) generated

in the first heat-generating member 2 is stored in the second reserve tank 12b.

[0048]

1.2 SECOND BASE OPERATION MODE (DESORBING PROCESS)

In the desorbing process, as shown in FIG. 3, the thermal medium circulates between the second heat collection portion 3a and the second in-cold-storage-unit heat exchanger 11b of the cold storage unit 11, so that the second heat-generating member 3 is cooled by the cold stored in the cold storage unit 11. At the same time, the thermal medium is circulated between the first heat collection portion 2a and the adsorption core 6, so that exhaust heat from the first heat-generating member 2, recovered in the first heat collection portion 2a, is supplied to the adsorbent, and the refrigerant adsorbed in the adsorbent is removed from the adsorbent. Further, the thermal medium cooled in the exterior heat exchanger 8 is supplied to the evaporation / condensation core 7, so that the gas refrigerant desorbed from the adsorbent of the adsorption core 6 is cooled and condensed.

[0049]

Further, the amount of the thermal medium supplied to the adsorption core 6, that is, the cooling device 4 from the second reserve tank 12b is made larger than that the thermal medium flowing into the first heat collection portion 2a from the first reserve tank 12a, so that the amount of the thermal medium within the second reserve tank 12b becomes substantially zero when this mode is finished.

[0050]

2. DIRECT COOLING MODE

The direct cooling mode is performed when the outside air temperature is extremely low in the winter, or when the outside air temperature is lower than a cooling temperature of the second heat-generating member 3 (i.e., permissible heat-resistance temperature of second heat-generating member 3), or when the cooling device 4 has a trouble.

[0051]

Specifically, as shown in FIG. 4, the thermal medium circulates between the first heat collection portion 2a of the first heat-generating member 2 and the first heat radiation portion 8a, and the thermal medium circulates between the second heat collection portion 3a of the second heat-generating member 3 and the second heat radiation portion 8b. Therefore, heat generated in the first and second heat-generating members 2, 3 is radiated to outside air in the exterior heat exchanger 8.

[0052]

The outside air temperature is detected by an outside air temperature sensor (outside air temperature detecting means). In this embodiment, the direct cooling mode is performed when the detected outside air temperature is equal to or lower than 15 °C.

[0053]

The trouble of the cooling device 4 is determined when the pressure in the adsorption unit 5 becomes equal to or higher than a predetermined value (e.g., 70 Kpa in this embodiment), or when the temperature of the thermal medium flowing from the evaporation / condensation core 7 becomes equal to or higher than a

predetermined value (e.g., 20 °C in this embodiment) in the adsorbing process, or when the temperature of the thermal medium flowing from the evaporation / condensation core 7 becomes equal to the temperature of the thermal medium in the inlet of the evaporation / condensation core 7, or when the temperature of the thermal medium flowing into the adsorption core 6 of the adsorption unit 5 becomes equal to the temperature of the thermal medium flowing out from the adsorption core 6.

[0054]

In the direct cooling mode, the flow direction of the thermal medium in the pump 10c is opposite to that in the base operation mode. Therefore, a bypass circuit through which the thermal medium bypasses the pump 10c can be provided. Alternatively, a pump capable to be operated normally or reversely can be used as the pump 10c.

[0055]

3. TROUBLE OPERATION MODE

The trouble operation mode is a backup mode which is performed when a trouble of the cooling device 4 occurs and the direct cooling mode cannot be performed.

[0056]

Specifically, as shown in FIG. 5, while the blower 12c is operated, and the thermal medium is circulated among the first heat collection portion 2a of the first heat-generating member 2, the first reserve tank 12a and the second reserve tank 12b. At the same time, the thermal medium is circulated between the second heat collection portion 3a of the second heat-generating

member 3 and the second heat radiation portion.

[0057]

In the trouble operation mode, the thermal medium flows in the pump 10c reversely, so that the bypass circuit through which the thermal medium bypasses the pump 10c is provided, or the pump capable to be operated normally or reversely can be used as the pump 10c. Further, radiation fins may be provided in the first reserve tank 12a. In this case, heat radiation performance in the first reserve tank 12a can be effectively improved.

[0058]

Next, features of this embodiment will be described.

[0059]

According to the first embodiment, the cold produced by the cooling device 4 is stored in the cold storage unit 11. Therefore, in the desorbing process, the second heat-generating member 3 can be cooled by using the cold stored in the cold storage unit 11, as described above. Thus, the second heat-generating member 3 can be continuously cooled by using the single adsorption unit 5, thereby reducing the manufacturing cost of the cooling system.

[0060]

The present invention is for reducing the number of the adsorption units 5. Therefore, the single adsorption unit 5 can be used, and plural adsorption unit 5 having a reduced number can be also used. That is, the present invention is not limited to only the single adsorption unit 5.

[0061]

Further, the second heat-generating member 3 is cooled

through the cold storage unit 11. Therefore, the cold storage unit 11 can absorb the variation in the temperature of the adsorption unit immediately after the switching between the adsorbing process and the desorbing process. Accordingly, a large cooling temperature variation of a cooling object such as an electronic machine can be restricted, so that bad affection to the cooling object such as the electronic machine can be restricted.

[0062]

In the first embodiment, the second heat-generating member 3 is cooled by the cold stored in the cold storage unit 11 in both the adsorbing process and the desorbing process, so that the variation of the cooling temperature of the second heat-generating member 3 can be further restricted.

[0063]

As described above, in this embodiment, the cold can be stably supplied to the heat generating body that is the cooling object, and the number of compartments for constructing the cooling system can be reduced.

[0064]

Further, in the first embodiment, because the exhaust heat generated in the first heat-generating member 2 is not consumed in the cooling device 4 in the adsorbing process, the first heat-generating member 2 may be not cooled in the adsorbing process. However, the thermal medium heated by cooling the first heat-generating member 2 is stored in the second reserve tank 12b, so that the cooling of the first heat-generating member 2 can be continuously performed even when the exhaust heat generated in

the first heat-generating member 2 is not consumed in the cooling device 4.

[0065]

(SECOND EMBODIMENT)

In the first embodiment, the thermal medium is circulated between the evaporation / condensation core 7 and the first in-cold-storage-unit heat exchanger 11a, so that the cold storage material is cooled and the cold is stored in the cold storage unit 11. When the adsorption unit 5 operates in the adsorbing process (first base operation mode), the refrigerant within the adsorption unit 5 is in a saturation temperature corresponding to the inner pressure in the adsorption unit 5. Accordingly, in the second embodiment, the cold storage material used only for the cold storage unit 11 is not provided. In the second embodiment, in the adsorbing process, liquid refrigerant is supplied from the adsorption unit 5 to the cold storage unit 11, so that the cold is stored in the cold storage unit 11.

[0066]

Specifically, as shown in FIG. 6, a pump 10f for supplying the liquid refrigerant in the adsorption unit 5 to the cold storage unit 11 is provided, and nozzles 13 for jetting the liquid refrigerant in the cold storage unit 11 into the adsorption unit 5 are provided. The liquid refrigerant in the cold storage unit 11 is jetted in liquid drops to the adsorption unit 5 through the nozzles 13.

[0067]

The valves 13a, 13b are provided to control a refrigerant

flow supplying to the nozzles 13, and the valves 9m, 9n are provided to control a thermal medium flow in the evaporation / condensation core 7.

[0068]

Next, operation mode of the cooling system according to the second embodiment will be now described.

[0069]

1.1 FIRST BASE OPERATION MODE (ADSORBING PROCESS)

In this mode, as shown in FIG. 7, the thermal medium is circulated between the second heat collection portion 3a and the second in-cold-storage-unit heat exchanger 11b of the cold storage unit 11. Therefore, the second heat-generating member 3 is cooled by using the cold stored in the cold storage unit 11, and liquid refrigerant in the cold storage unit 11 is jetted into the adsorption unit 5 while liquid refrigerant in the adsorption unit 5 is supplied to the cold storage unit 11.

[0070]

Accordingly, the refrigerant jetted into the adsorption unit 5 is evaporated by absorbing heat in the adsorption unit 5, and the evaporated gas refrigerant is adsorbed into the adsorbent. At this time, the refrigerant in the adsorption unit 5 becomes the saturation temperature corresponding to the inner pressure within the adsorption unit 5. Therefore, the temperature of the liquid refrigerant in the adsorption unit 5 decreases, and cold is produced. That is, the liquid refrigerant in the adsorption unit 5 is cooled, and the cooled liquid refrigerant is supplied to the cold storage unit 11 so that the cold is stored in the cold

storage unit 11.

[0071]

When the absorbent absorbs gas refrigerant, the heat quantity corresponding to the condensation heat is generated, and the adsorbing capacity of the adsorbent decreases as the temperature of the adsorbent increases. Accordingly, the thermal medium cooled in the exterior heat exchanger 8 is supplied to the adsorption core 6 for cooling the adsorbent.

[0072]

The pump 10a is operated while the pump 10d stops. Therefore, exhaust heat generated from the first heat-generating member 2 is recovered, and the recovered heat is stored in the second reserve tank 12b. That is, the thermal medium heated in the first heat-generating member 2 is stored in the second reserve tank 12b.

[0073]

1.2 SECOND BASE OPERATION MODE (DESORBING PROCESS)

In this mode, as shown in FIG. 8, the thermal medium is circulated between the second heat collection portion 3a and the second in-cold-storage-unit heat exchanger 11b of the cold storage unit 11, so that the second heat-generating member 3 is cooled by the cold stored in the cold storage unit 11. At the same time, the thermal medium is circulated in the adsorption core 6 so that exhaust heat recovered in the first heat collection portion 2a from the first heat-generating member 2 is applied to the adsorbent. Therefore, refrigerant is removed from the adsorbent, and the removed gas refrigerant from the adsorbent is cooled and condensed by supplying the thermal medium cooled in the exterior heat

exchanger 8 to the evaporation / condensation core 7.

[0074]

Further, the amount of the thermal medium supplied to the adsorption core 6 of the cooling device 4 from the second reserve tank 12b is larger than the amount of the thermal medium flowing from the first reserve tank 12a to the first heat collection portion 2a, so that the amount of the thermal medium in the second reserve tank 12b becomes approximately zero when this mode is finished.

[0075]

The valve 13b closes after a predetermined time passes after the pump 10f stops. Therefore, almost liquid refrigerant staying in the adsorption unit 5 at a start time of the desorbing process moves to the cold storage unit 11 due to the evaporation pressure of the refrigerant separated from the adsorbent. Accordingly, the liquid surface in the adsorption unit 5 is greatly decreased.

[0076]

That is, almost the liquid refrigerant staying in the adsorption unit 5 at a start time of the desorbing process is moved to the cold storage unit 11. The valve 13b is opened until the whole evaporation / condensation core 7 is exposed to the refrigerant separated from the adsorbent. After the liquid refrigerant staying in the adsorption unit 5 at the start time of the desorbing process almost moves to the cold storage unit 11, the valve 13b is closed in order to prevent the heated evaporation gas separated from the adsorbent from flowing to the cold storage unit 11.

[0077]

2. DIRECT COOLING MODE

The direct cooling mode is performed when the outside air temperature is extremely low in the winter, or when the outside air temperature is lower than a cooling temperature of the second heat-generating member 3 (i.e., permissible heat-resistance temperature of second heat-generating member 3), or when the cooling device 4 has a trouble.

[0078]

Specifically, as shown in FIG. 9, the thermal medium circulates between the first heat collection portion 2a of the first heat-generating member 2 and the first heat radiation portion 8a, and the thermal medium circulates between the second heat collection portion 3a of the second heat-generating member 3 and the second heat radiation portion 8b. Therefore, heat generated in the first and second heat-generating members 2, 3 is radiated to outside air in the exterior heat exchanger 8.

[0079]

3. TROUBLE OPERATION MODE

The trouble operation mode is a backup mode which is performed when a trouble of the cooling device 4 occurs and the direct cooling mode cannot be performed.

[0080]

Specifically, as shown in FIG. 10, the blower 12c is operated, and the thermal medium is circulated among the first heat collection portion 2a of the first heat-generating member 2, the first reserve tank 12a and the second reserve tank 12b. At the same time, the thermal medium is circulated between the second

heat collection portion 3a of the second heat-generating member 3 and the second heat radiation portion 8b.

[0081]

Next, effect according to operation of this embodiment is described.

[0082]

As described above, according to the second embodiment, the cold can be stably supplied to the heat generating body that is the cooling object, and the number of compartments for constructing the cooling system can be reduced, similarly to the first embodiment.

[0083]

Further, the liquid refrigerant staying in the adsorption unit 5 at the start time of the desorbing process is almost moved to the cold storage unit 11, and the whole evaporation / condensation core 7 is exposed to the refrigerant separated from the adsorbent. Therefore, in the desorbing process, gas refrigerant can be effectively cooled and condensed in the evaporation / condensation core 7.

[0084]

In the second embodiment, the valve 13b is closed, after the predetermined time passes after the pump 10f stops at the start time of the desorbing process. However, the pump 10f can be operated while the valve 13b is opened, for a predetermined time after the desorbing process starts, and the valve 13b may be closed simultaneously at the time when the pump 10f stops after the predetermined time passes. In this case, almost the liquid

refrigerant staying in the adsorption unit 5 at the start time of the desorbing process can be moved to the cold storage unit 11 in a short time, and the above-described predetermined time can be shortened.

[0085]

(THIRD EMBODIMENT)

The third embodiment is a modification of the second embodiment. As shown in FIG. 11, the evaporation / condensation core 7 is positioned above the top liquid surface in the adsorption unit 5 in the cooling system of the second embodiment.

[0086]

Accordingly, the gas refrigerant can be more effectively cooled and condensed in the evaporation / condensation core 7 in the desorbing process, as compared with the second embodiment. Further, in the third embodiment, it can prevent cold generated in the adsorbing process from being moved to the evaporation / condensation core 7. Therefore, cold can be more effectively stored in the cold storage unit 11.

[0087]

(OTHER EMBODIMENT)

In the above-described embodiments, the present invention is typically applied to the base station. However, the present is not limited to this. The present invention can be used for cooling various-type heat-generating members disposed in a space of a building, a basement, a factory, a shed, a home, a garage or a vehicle. For example, the heat-generating member is a gas turbine engine, a gas engine, a diesel engine, a gasoline engine,

a fuel cell, an electronic machine, an electrical machine, an electric converter, an accumulator, an animal including humans or the like.

[0088]

Here, the space is not limited to be an entirely closed space, but can be an opened space.

[0089]

Further, the portion to which heat is radiated (heat radiation object, except for cooling device 4 and 11) of the cooling system is not limited to be positioned in outside air (i.e., atmosphere), but can be positioned in the river, the underground water, the soil, the seawater and the space.

[0090]

Moreover, the refrigerant is not limited to be water. Alcohol and the like can also be used.

[0091]

In the above-described embodiments, the solid adsorbent is used as the adsorbent (adsorbing medium). However, the present invention is not limited to this. An adsorbing body, with a honeycomb structure and being immersed in liquid absorbent such as lithium bromide and ammonia, can be also used as the adsorbent.

According to the above-described embodiments, the cooling system of the present invention can be also used for a heat management system with a heater. The exhaust heat discharged from the cooling system can be used in the heater for heating a supply water, for heating air blown into a compartment, or for melting snow or the like.

[0092]

Further, in the above-described embodiments, the cooling system can be constructed such that, the second heat-generating member 3 can be directly cooled by the cooling device 4 in the adsorbing process, and can be indirectly cooled by the cold stored in the cold storage unit 11 in the cooling device 4 in the desorbing process.

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a schematic diagram showing a cooling system according to a first embodiment of the present invention.

FIG. 2 is a schematic diagram showing a thermal medium flow in a first basis operation mode according to the first embodiment of the present invention.

FIG. 3 is a schematic diagram showing a thermal medium flow in a second basis operation mode according to the first embodiment of the present invention.

FIG. 4 is a schematic diagram showing a thermal medium flow in a direct cooling mode according to the first embodiment of the present invention.

FIG. 5 is a schematic diagram showing a thermal medium flow in a trouble operation mode according to the first embodiment of the present invention.

FIG. 6 is a schematic diagram showing a cooling system according to a second embodiment of the present invention.

FIG. 7 is a schematic diagram showing a thermal medium flow in a first basis operation mode according to the second embodiment of the present invention.

FIG. 8 is a schematic diagram showing a thermal medium flow in a second basis operation mode according to the second embodiment of the present invention.

FIG. 9 is a schematic diagram showing a thermal medium flow in a direct cooling mode according to the second embodiment of the present invention.

FIG. 10 is a schematic diagram showing a thermal medium flow in a trouble operation mode according to the second embodiment of the present invention.

FIG. 11 is a schematic diagram showing a cooling system according to a third embodiment of the present invention.

[EXPLANATION OF SIGN]

1 ~ Base station for portable phone

2 ~ First heat-generating member

3 ~ Second heat-generating member

4 ~ Adsorption refrigerator

5 ~ Adsorption unit

6 ~ Adsorption core

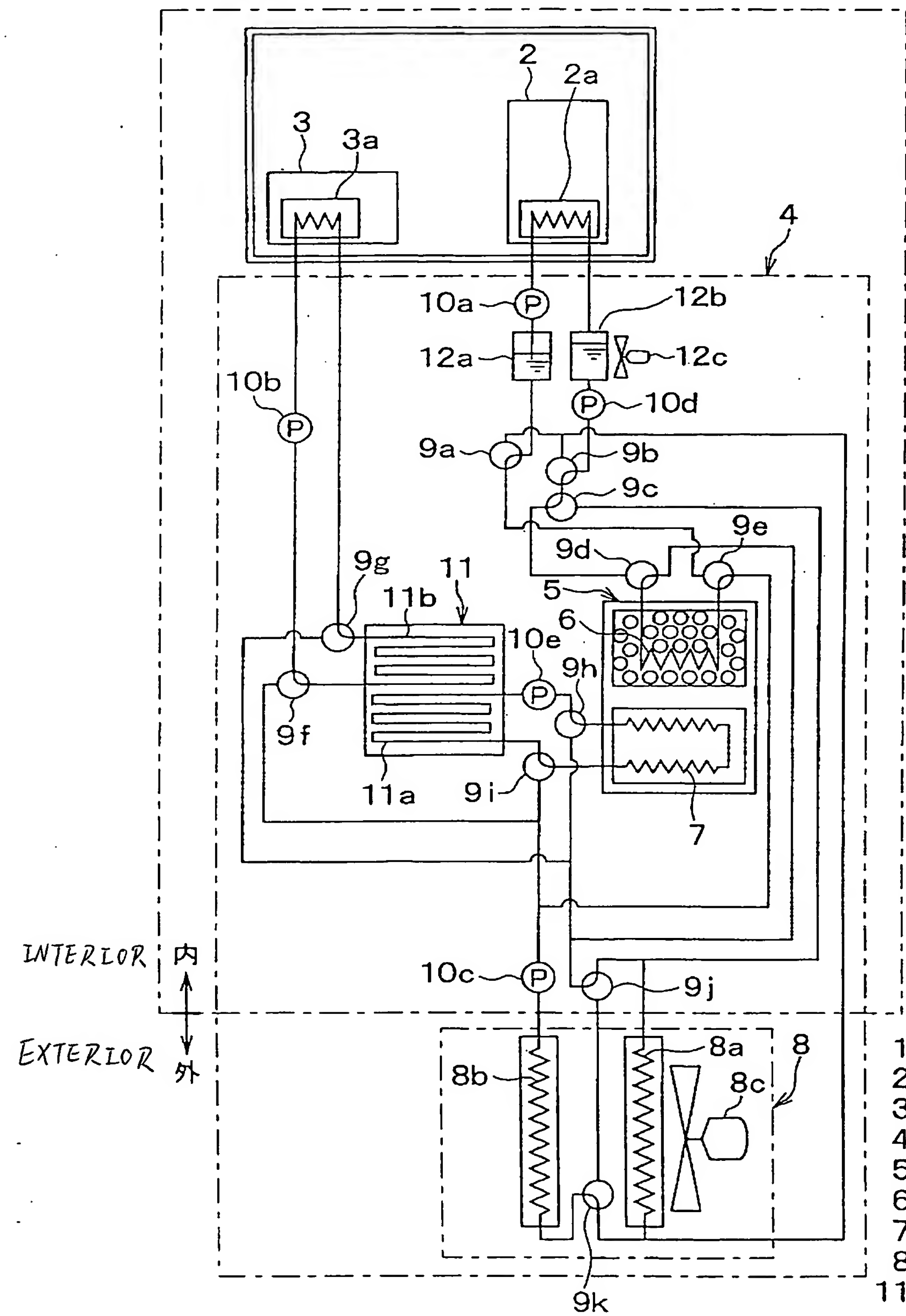
7 ~ Evaporation / condensation core

8 ~ Exterior heat exchanger

11 ~ Cold storage unit

【書類名】　図面　[NAME OF THE DOCUMENT] DRAWING

【図１】 [FIG. 1]

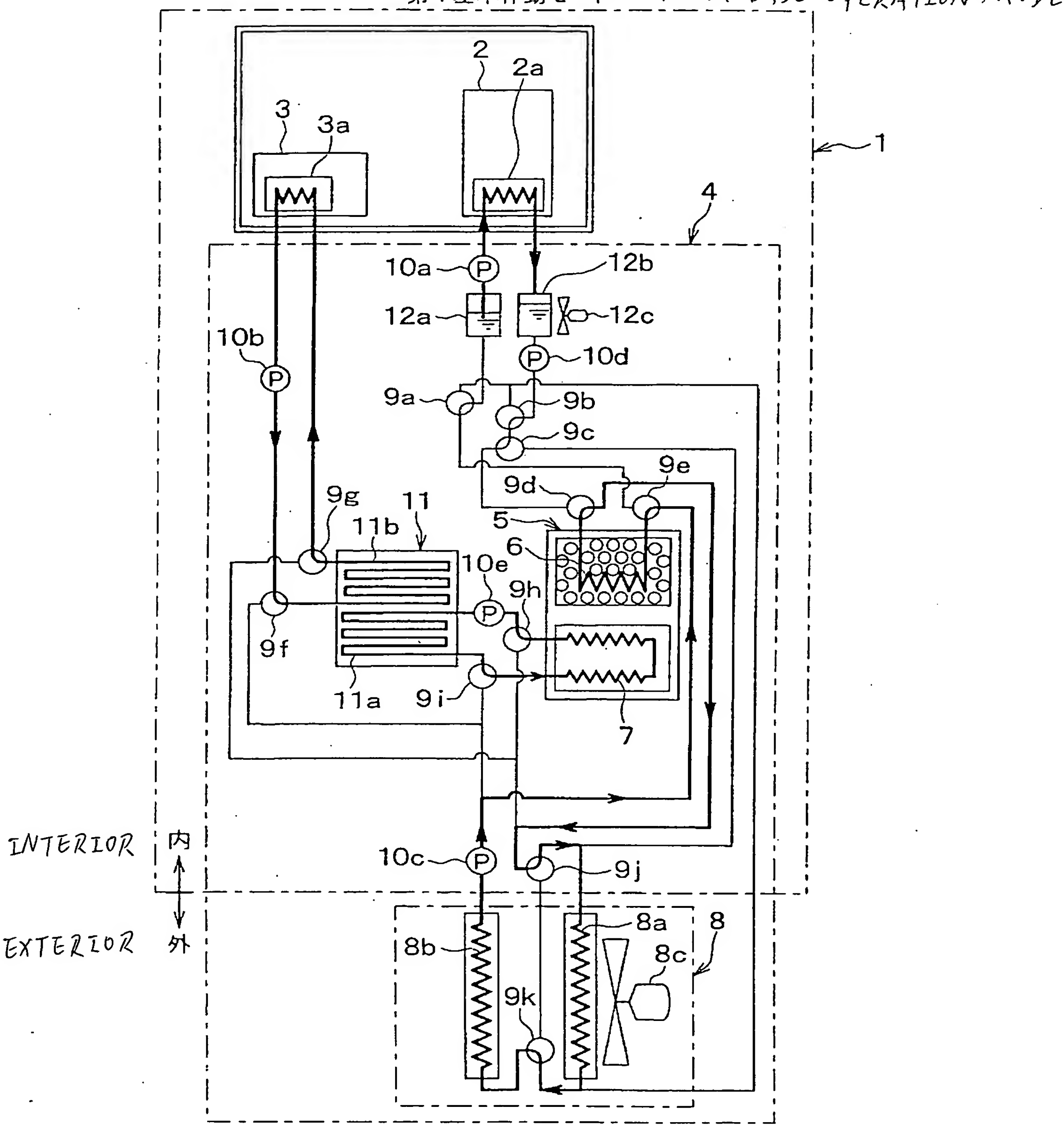



1: BASE STATION FOR PORTABL PHONE
2: FIRST HEAT-GENERATING MEMBER
3: SECOND HEAT-GENERATIN MEMBER
4: ADSORPTION REFRIGERATO
5: ADSORPTION UNIT
6: ADSORPTION CORE
7: EVAPORATION/CONDENSATIO CORE
8: EXTERIOR HEAT EXCHANGE
11: COLD STORAGE UNIT

１：携帯電話基地局
２：第１発熱体
３：第２発熱体
４：吸着式冷凍機
５：吸着器
６：吸着コア
７：蒸発／凝縮コア
８：室外熱交換器
１１：蓄冷器

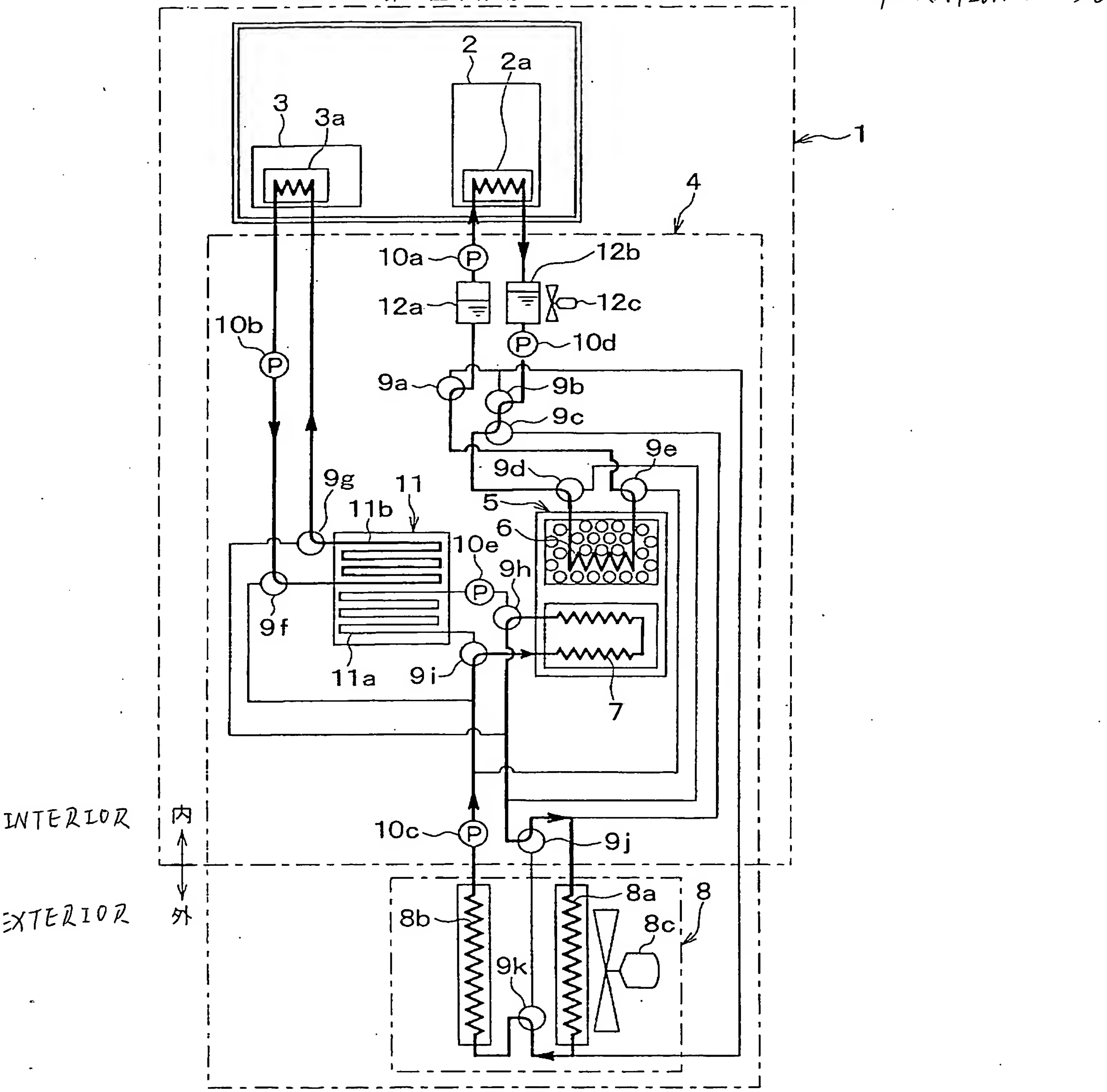
【図２】 [FIG. 2]

第１基本作動モード　FIRST BASE OPERATION MODE



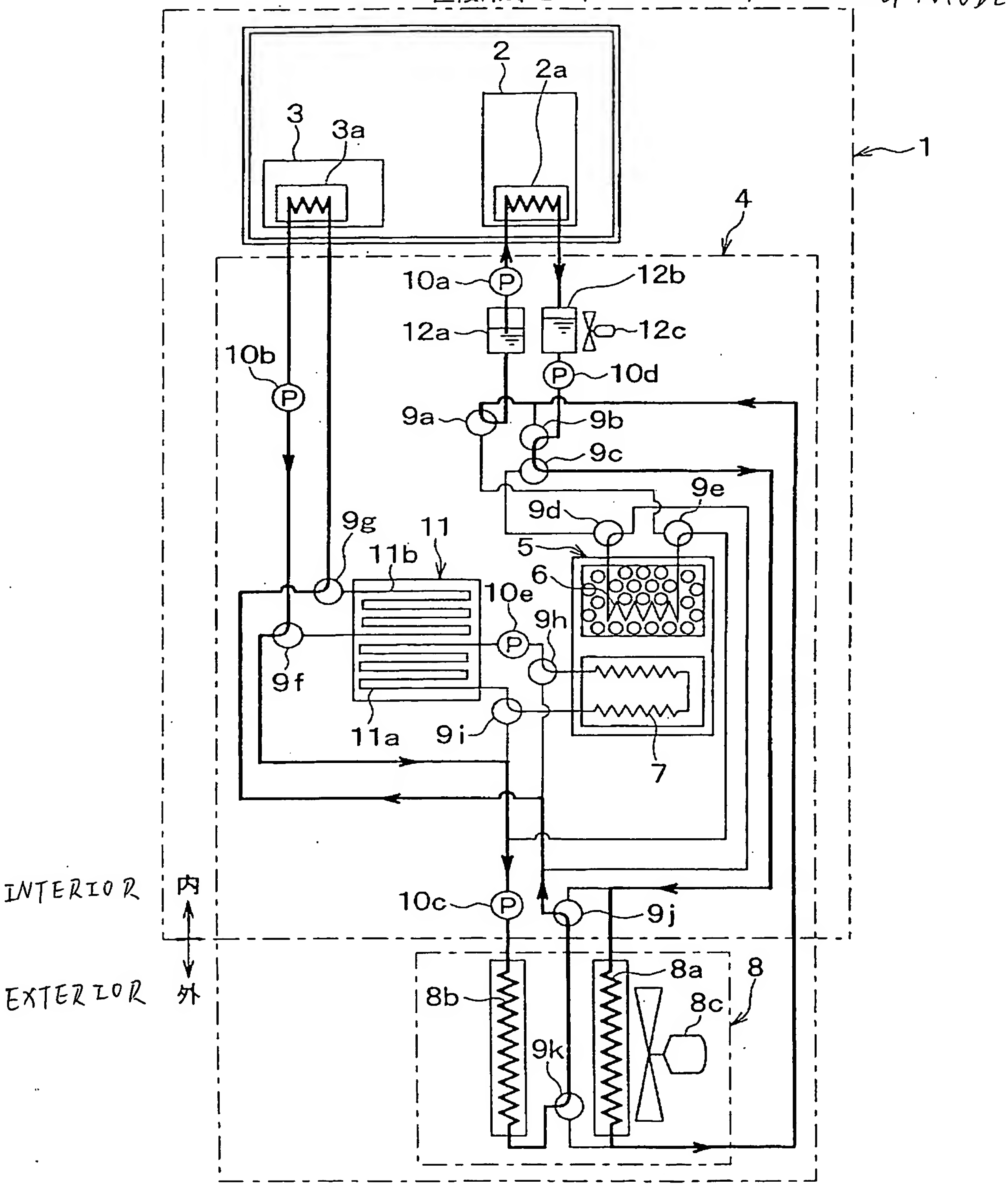
【図３】 [FIG. 3]

第２基本作動モード SECOND BASE OPERATION MODE



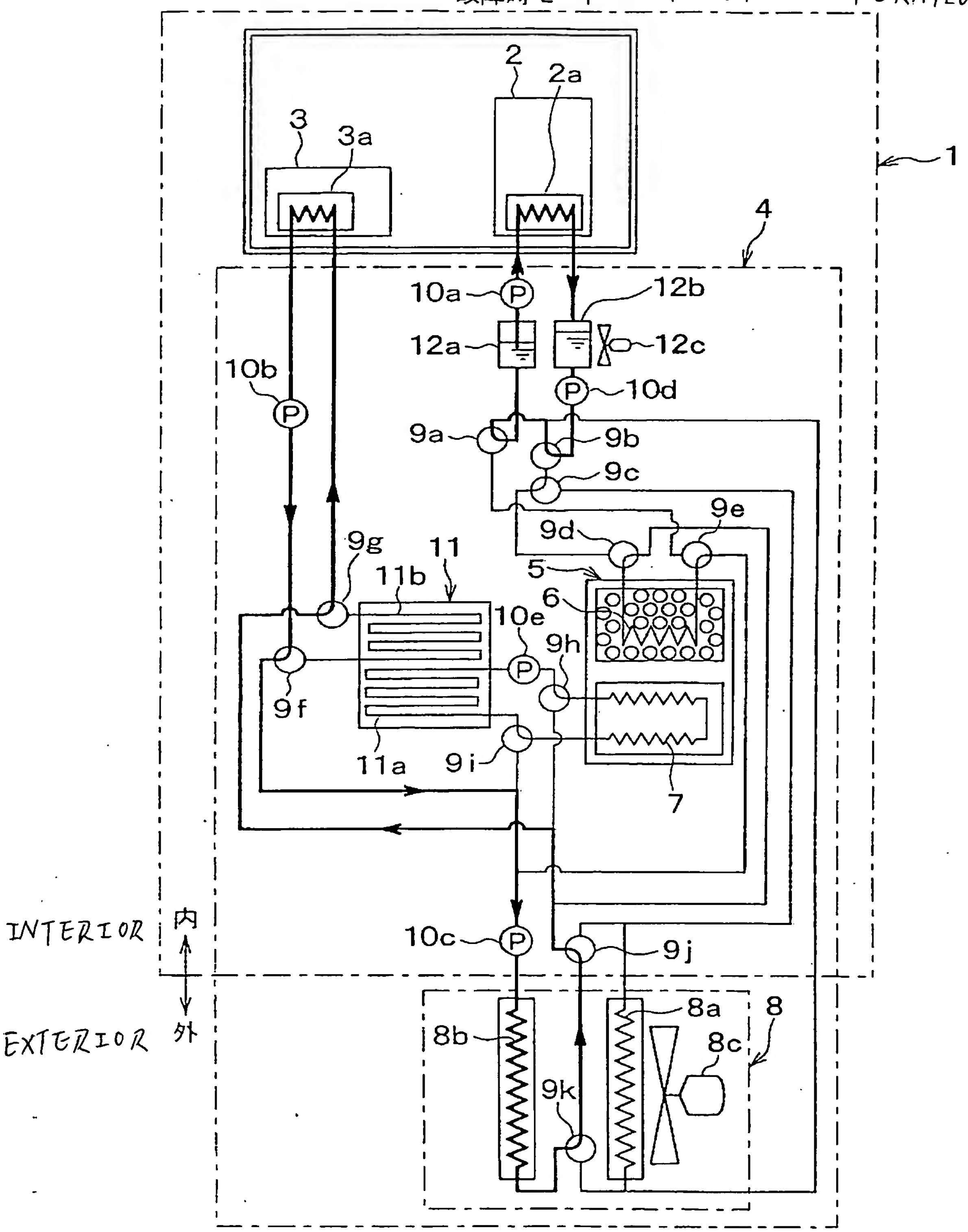
〔図４〕 [FIG. 4]

直接冷却モード　DIRECT COOLING MODE

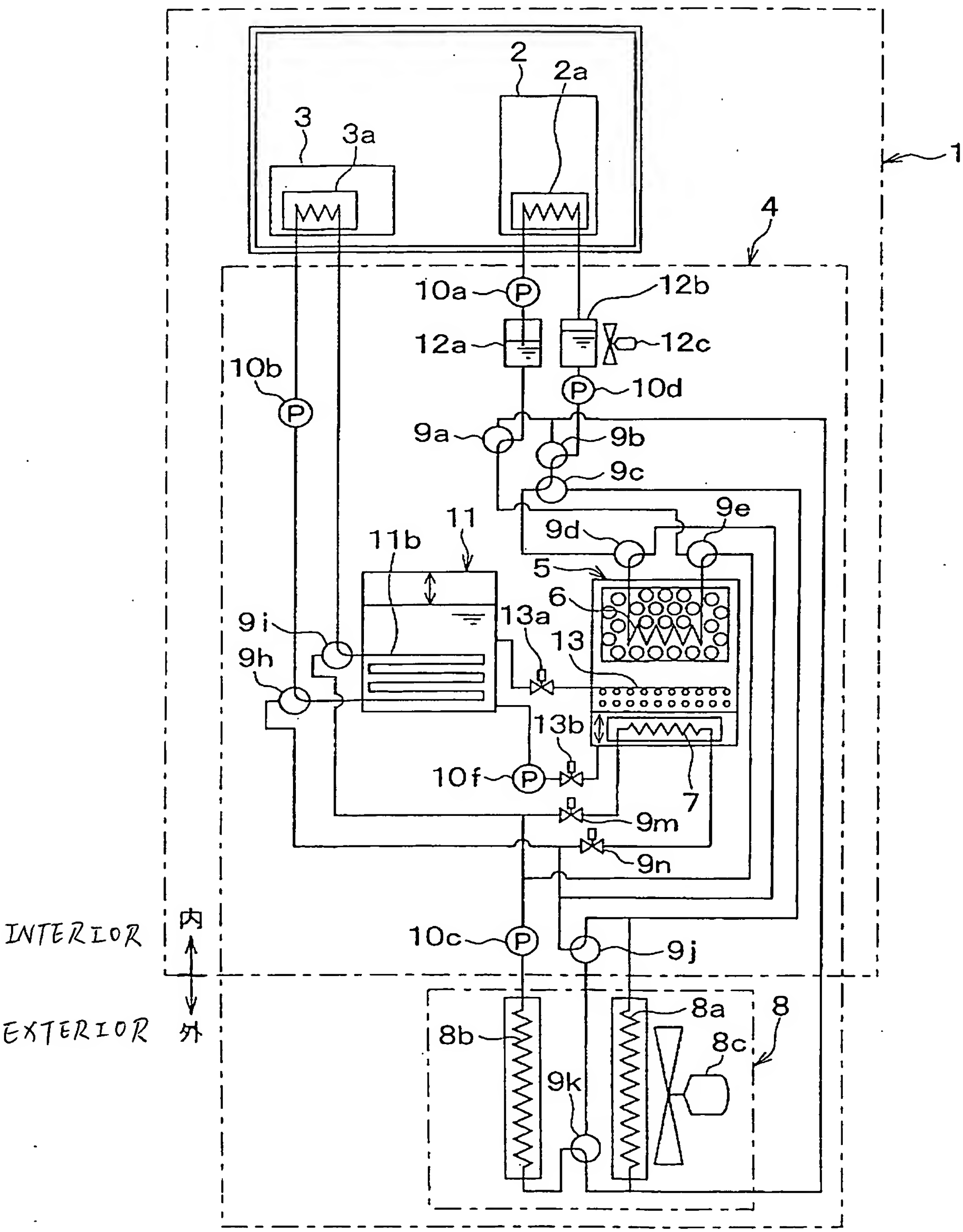


〔図５〕　[FIG. 5]

故障時モード　TROUBLE OPERATION MODE



【図６】　[FIG. 6]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9d
9e
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9i
9j
9k
9m
9n
10a
10b
10c
10d
10f
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11b
12a
12b
12c
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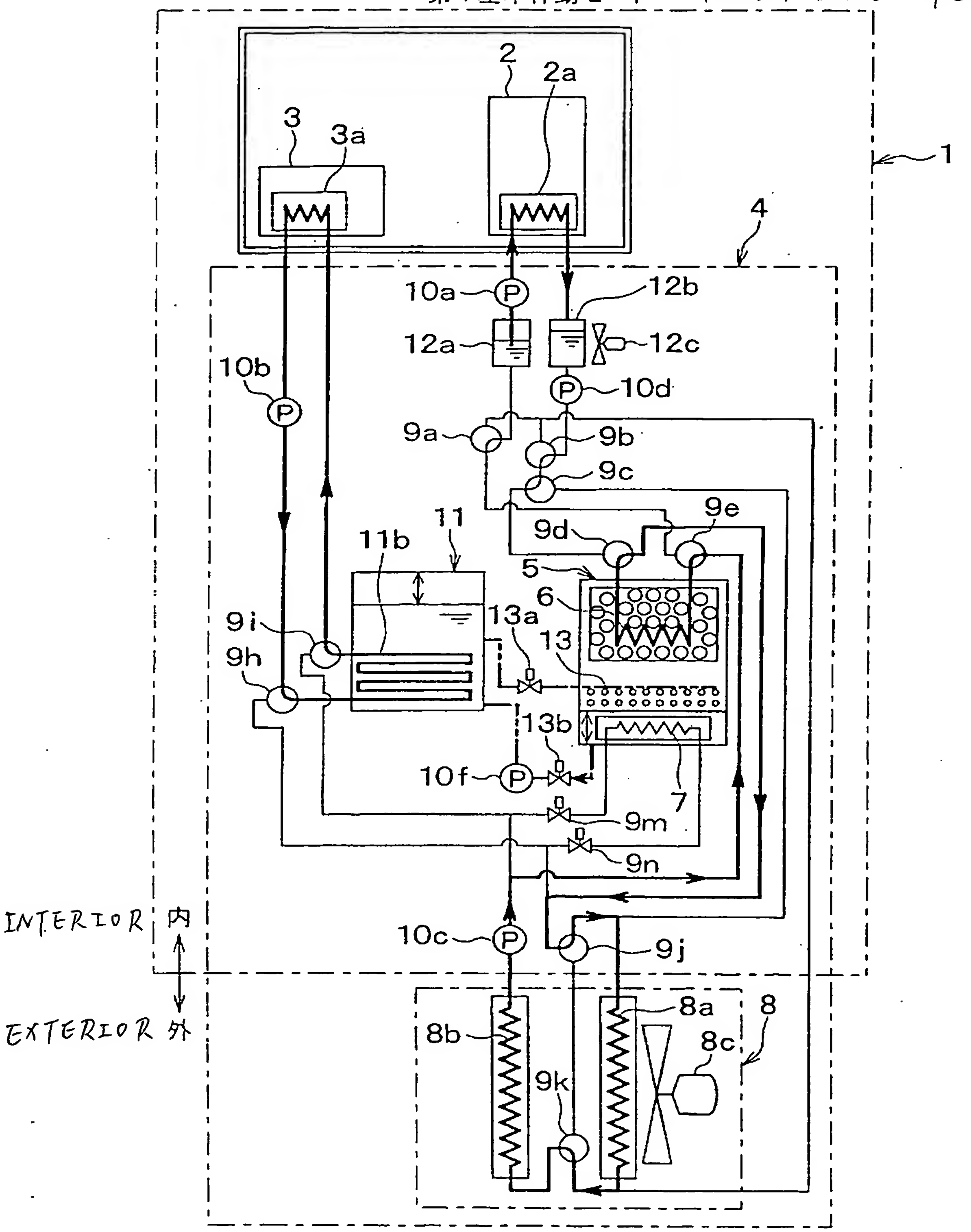
13a
13b
内
INTERIOR
外
EXTERIOR

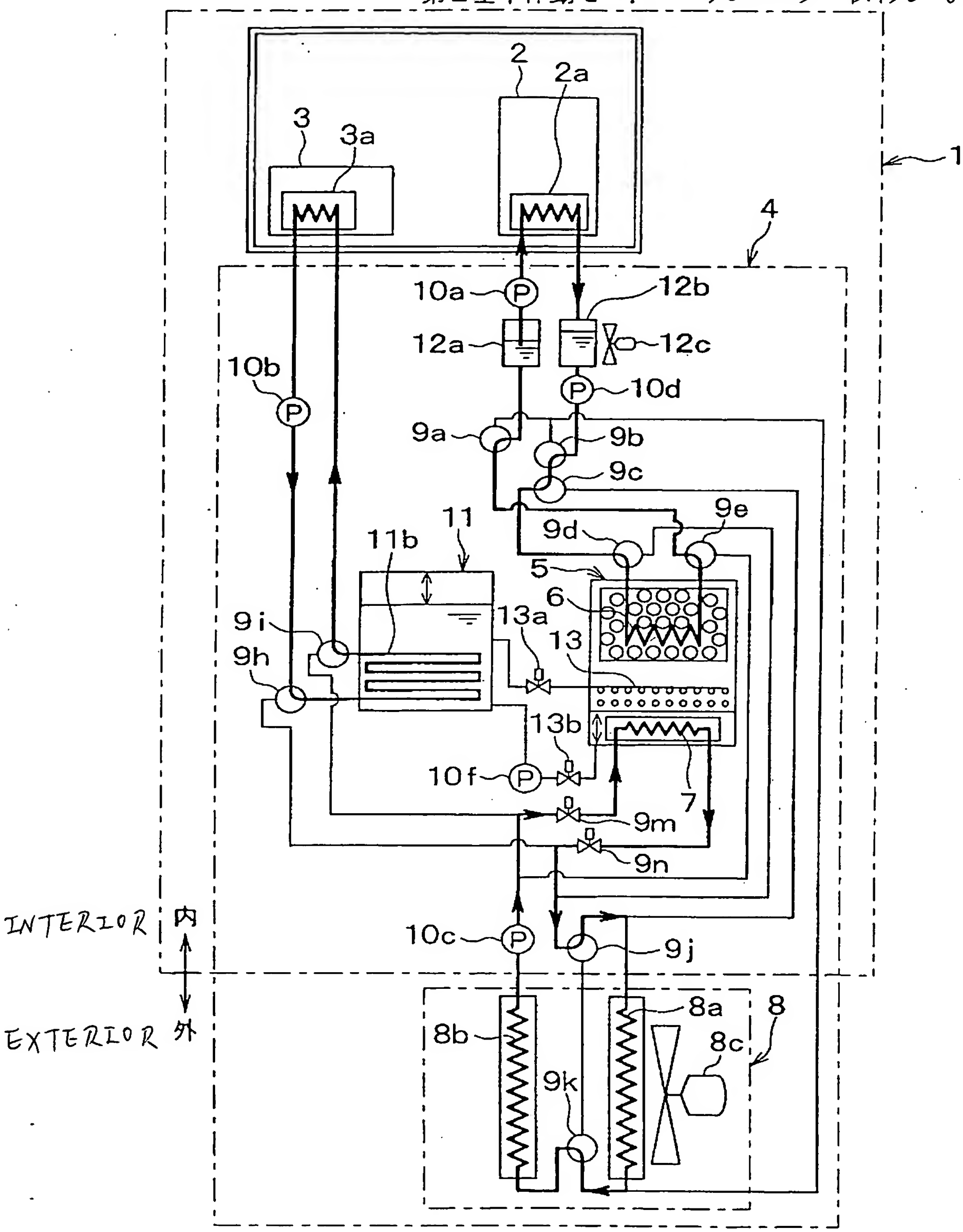
【図７】　[FIG. 7]

第１基本作動モード　FIRST BASE OPERATION MODE



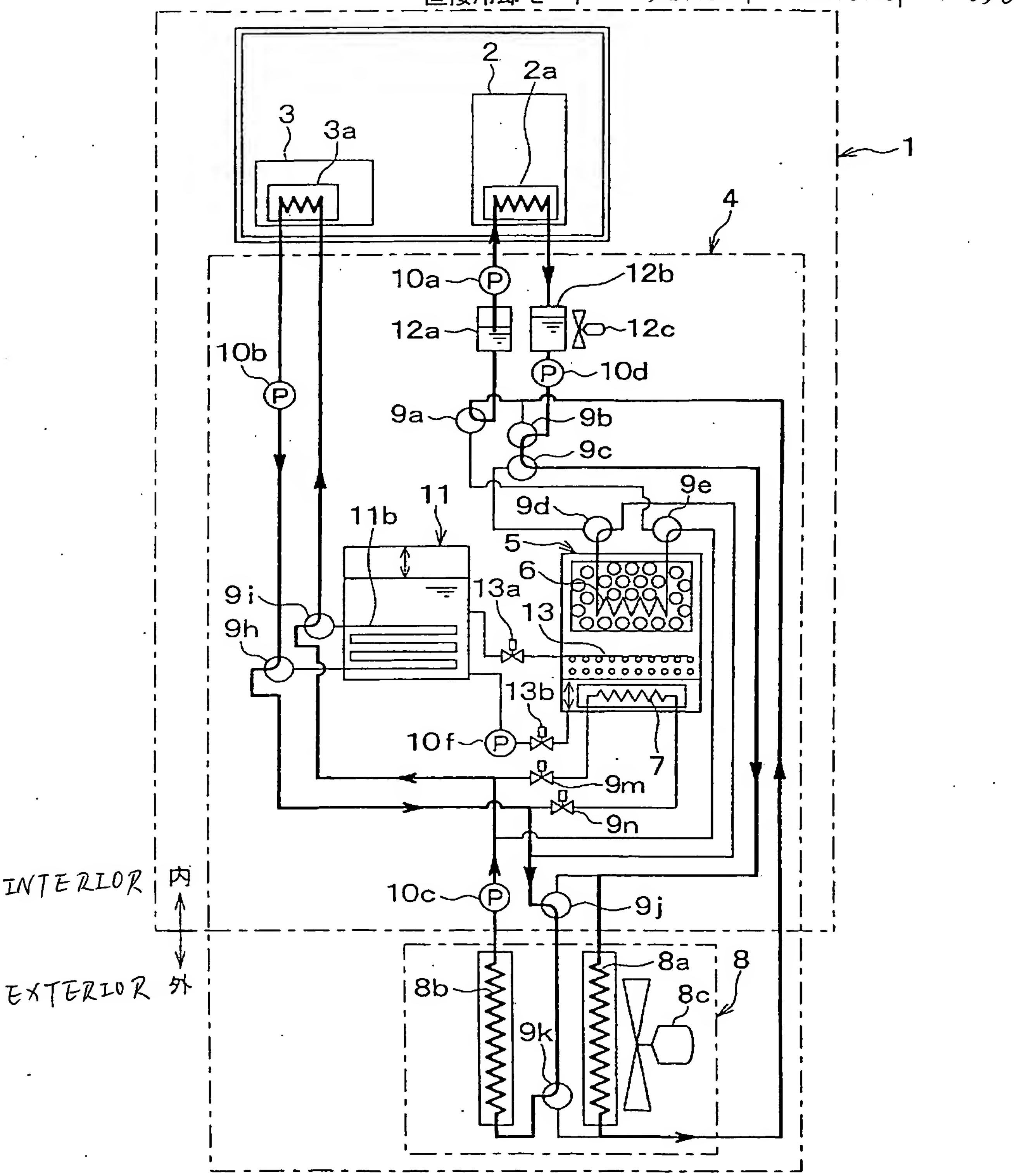
【図８】　[FIG. 8]

第２基本作動モード　SECOND BASE OPERATION MODE

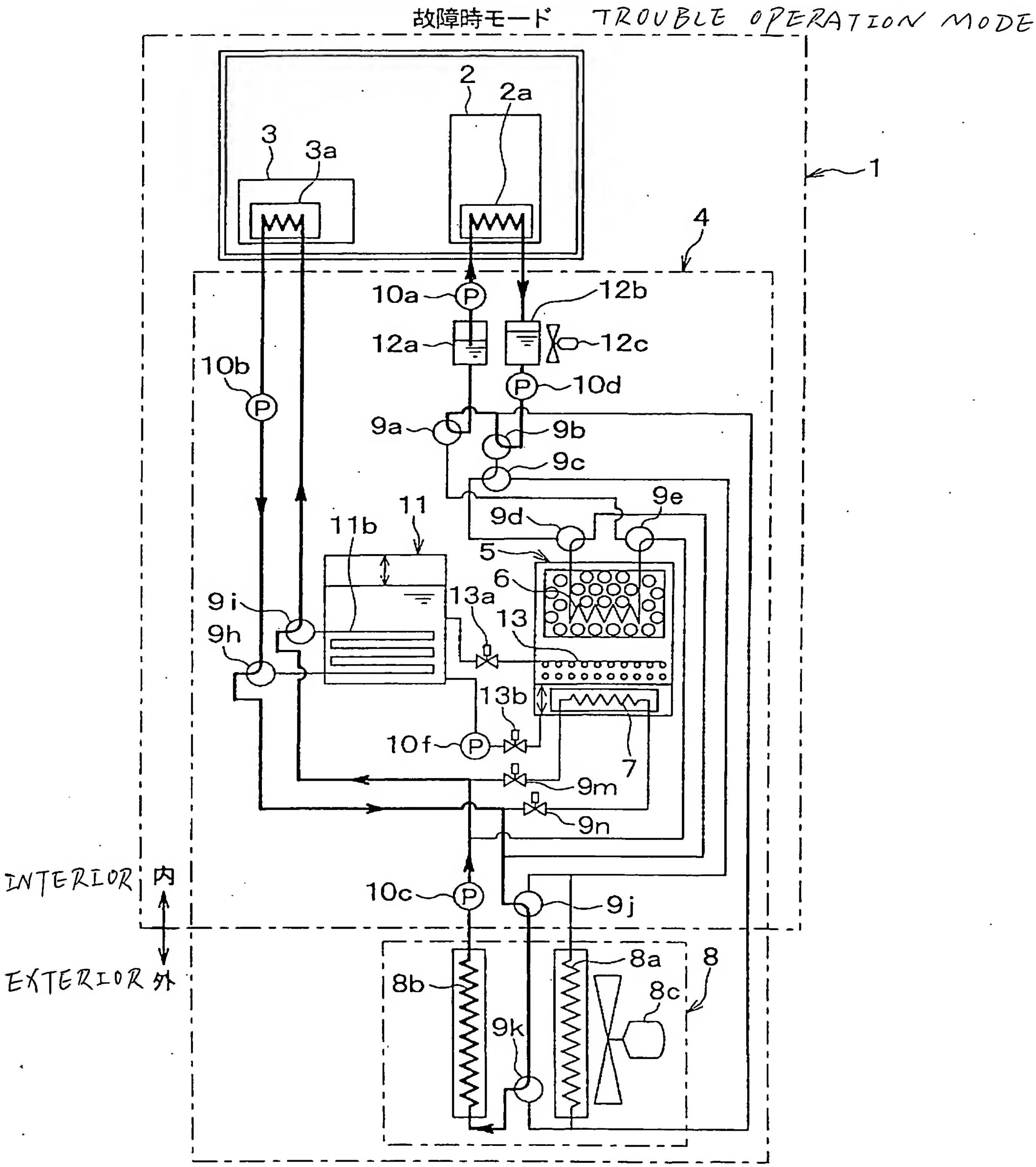


【図９】 [FIG. 9]

直接冷却モード　DIRECT COOLING MODE



【図１０】 [FIG. 10]


故障時モード TROUBLE OPERATION MODE
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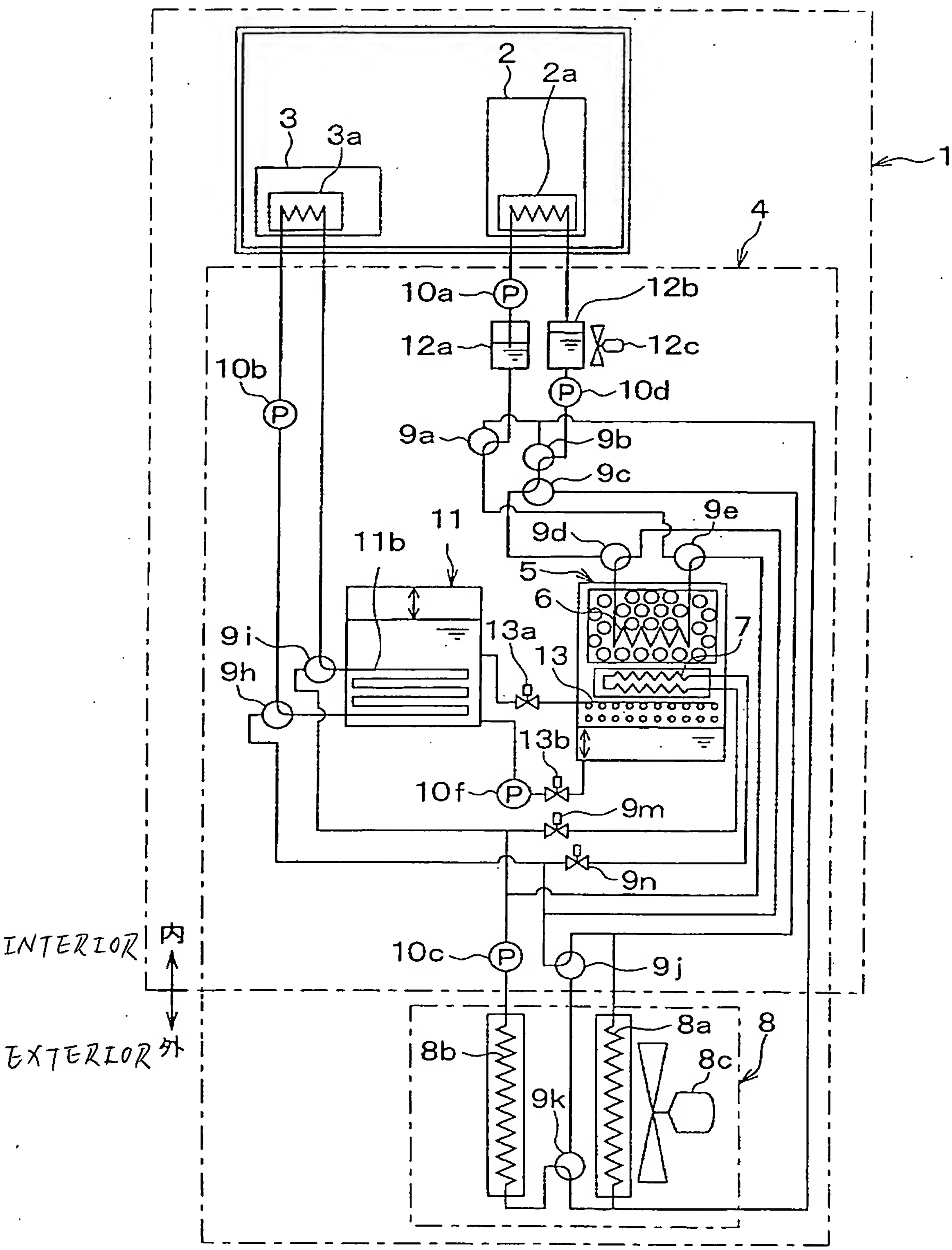
INTERIOR 内
EXTERIOR 外

【図１１】 [FIG. 11]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12a
12b
12c
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13a
13b
INTERIOR 内
EXTERIOR 外

[NAME OF THE DOCUMENT] ABSTRACT OF THE DISCLOSURE

[ABSTRACT]

[OBJECT]

Cold can be stably supplied to a heat-generating member that is an object body to be cooled, and the number of components constructing a cooling system can be reduced.

[MEANS FOR SOLVING PROBLEMS]

Cold produced by a cooling device 4 is stored in a cold storage unit 11, and a second heat-generating member 3 is cooled through the cold storage unit 11. Thus, the second heat-generating member 3 can be continuously cooled by using a single adsorption unit 5, thereby a product cost of a cooling system can be reduced. Further, because the second heat-generating member 3 is cooled through the cold storage unit 11, a temperature change in the adsorption unit immediately after a switching between an adsorbing process and a desorbing process can be absorbed in the cold storage unit 11. Therefore, a variation of a cooling temperature of a cooling object such as an electronic equipment can be decreased. Accordingly, a bad influence to the cooling object such as the electronic equipment can be decreased. As a result, the cold can be stably supplied to the heat-generating member that is an object body to be cooled, and the number of components constructing the cooling system can be reduced.

[SELECTED FIGURE] FIG. 1